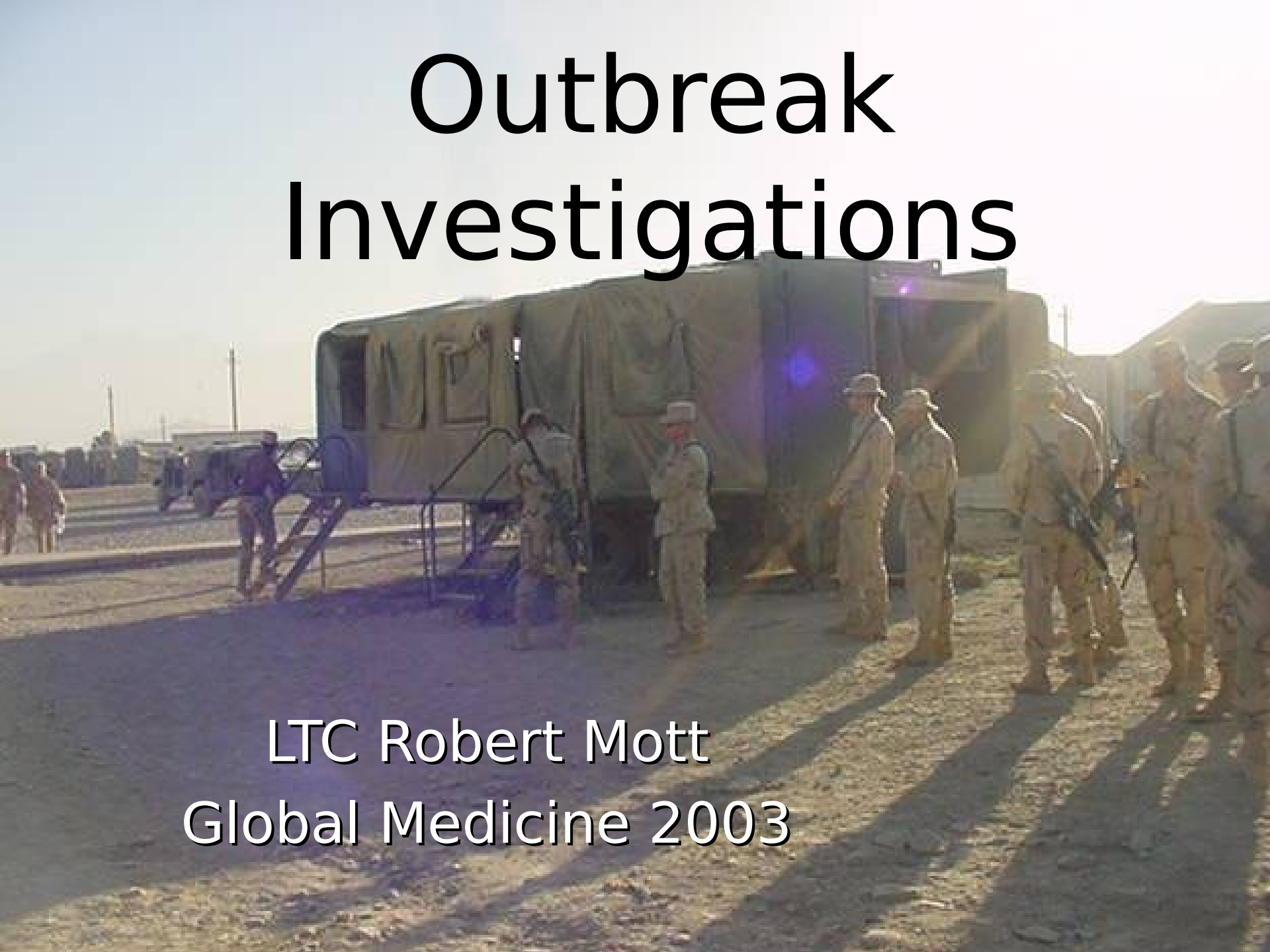
Outbreak Investigations



LTC Robert Mott

Global Medicine 2003

Saudi Arabia, 1991

Saudi Arabia, 1991

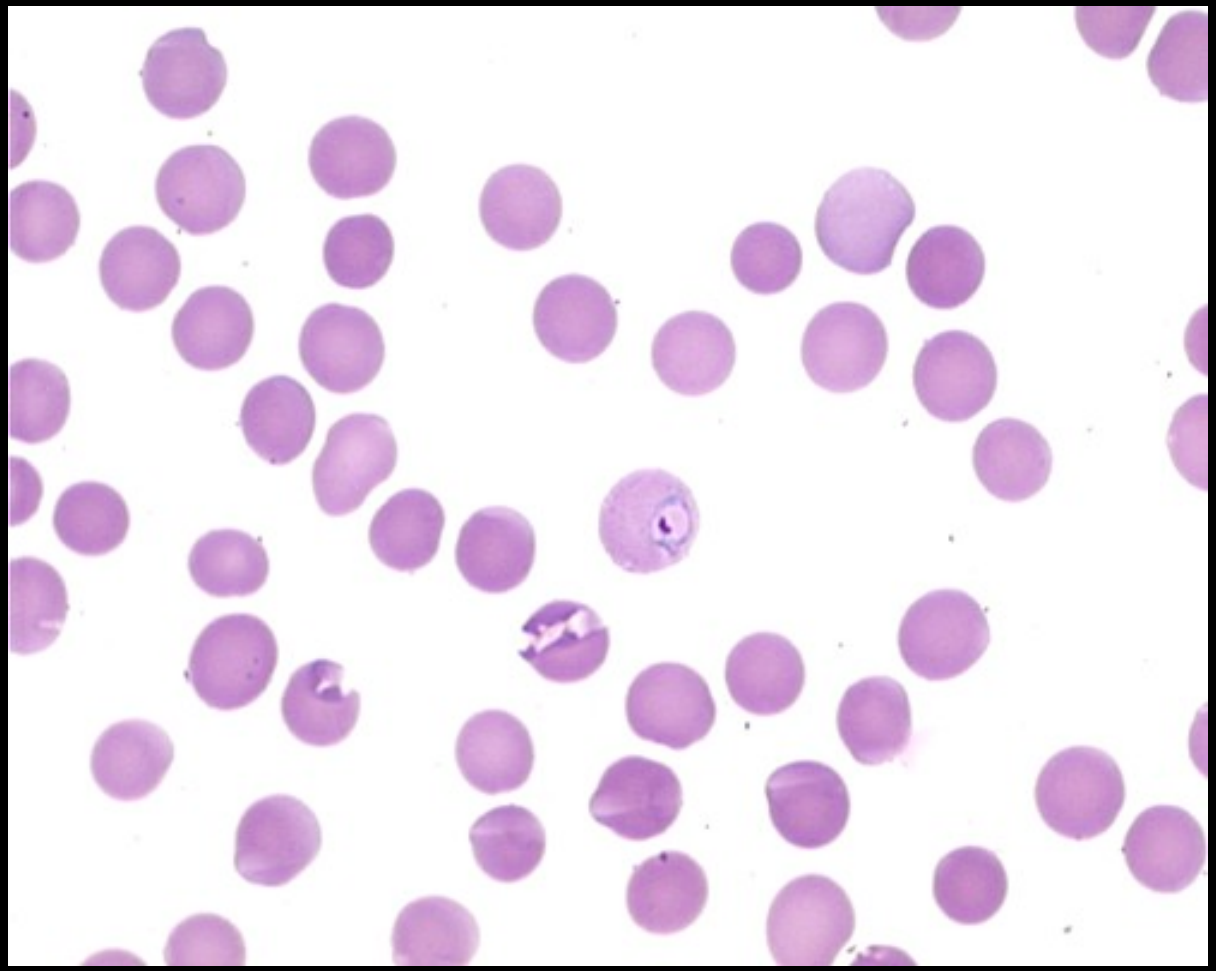
- U.S. Air Force personnel during DESERT STORM
- 648 cases of dysentery
- Strain on operations and medical support
- Cause: Locally catered meal

Bosnia, 1996

Bosnia, 1996

- Task Force Headquarters during buildup stage
- Large percentage of the headquarters staff developed diarrheal disease
- Limited medical assets overwhelmed
- Cause: Flooded stream contaminated the drinking water cistern

Puerto Rico, 2001



Puerto Rico, 2001

- U.S. Army Reserve Unit who had deployed for 2 weeks to Guatemala
- Nine cases of *Plasmodium vivax* malaria
- Cause: Poor compliance with chemoprophylaxis and Personal Protective Measures (PPM)

Afghanistan, 2002

Afghanistan, 2002

- British Military personnel
- 3 soldiers presented with fever, headache, stiff neck, photophobia, obtundation, and N/V/D. Two required ventilator support. Total of 29 cases overall.
- Concern about biological warfare
- Field hospital closed to non-outbreak cases
- 11 cases evacuated to Europe
- Cause: Norwalk-like virus

Baghdad, 2004

Baghdad, 2004

- U.S. Peacekeeping Force
- 8 cases of severe respiratory disease, 1 death
- Is this an outbreak?
- What is the cause?
  - Influenza, Hantavirus, Anthrax?
- How can we stop it?

Outline

- What is an outbreak?
- Procedures for an outbreak investigation
- Pitfalls
- Data analysis

What is an Outbreak?

Epidemic: An increase in cases of a disease above what is normally expected in that population in that area

Outbreak: Same as epidemic but in a more limited geographic area

Cluster: An aggregation of cases grouped in place and time that are suspected to be greater than the expected number

Why do we investigate outbreaks?

- Prevent further disease transmission
- Identify populations at risk
- Prevent future outbreaks
- Evaluate control programs
- Characterize modes of transmission
- Learn more about a disease
- Train public health staff

Summary of Investigation Steps

1. **Prepare for field work**
2. **Establish the existence of an outbreak**
3. **Verify the diagnosis**
4. **Define and identify cases**
5. **Perform descriptive epidemiology**
6. **Develop hypothesis**
7. **Evaluate hypothesis**
8. **Refine hypothesis and execute additional studies**
9. **Implement control and prevention measures**
10. **Communicate findings**

1. Prepare for field work

- Know your mission, role, boundaries
- Review the literature
- Establish call-back capabilities, lab consultation
- Select and prepare the team
- Admin: travel, funding, visas, etc.
- Gather equipment, supplies
- Establish reporting requirements

2. Establish the existence of an outbreak

- Determine if the disease incidence is higher than expected in this population

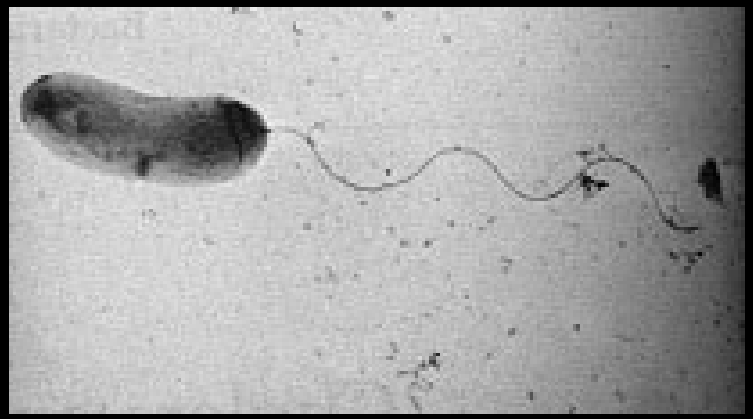
  - Historical documents
  - Medical literature
  - After Action Reports
  - Surveillance!!

Reasons why you might observe more than expected

- Change in reporting procedures
- Change in case definition
- Increased awareness in medical community and/or public
- Improved diagnostics
- New clinician
- Population change

3. Verify the diagnosis

- Ensure proper diagnosis (don’t assume they are right!)
- Rule out lab and clinician error
- Visit and interview patients



4. Define and identify cases

- Critical to the success of an investigation
- Definition composed of:
  - Clinical criteria: simple and objective
  - Epidemiologic variables: Person, place, and time
- Useful to use established case definitions if available (CDC, medical literature)
- Classifications:
  - Confirmed, Probable, Suspect
  - Definite, Probable, Possible

Case Definition Components

- Clinical Criteria Examples:
  - Fever 101 degrees F and above
  - Three or more loose stools per day
  - Headache severe enough to limit activity

- Epidemiologic Variables:
  - Person with no immunity to or past history of rubella
  - Place: Workers or attendees of child care center
  - Time: Contact period between 14-20 February

Examples of Case Definitions (meningococcal disease outbreak)

- Confirmed: In a patient with an epidemiologic link, isolation of *N. meningitidis* in the blood or CSF, or the lab demonstration of group C meningococcal antigen in the CSF, with the serotype, serosubtype, and LOS type determined as C:2a:P1.5,2:L3,7
- Probable: Same as confirmed but without definitive serotype information
- Suspect: Sudden onset of fever (>38.5°C rectal) and one or more of the following: neck stiffness, altered consciousness, other meningeal sign or petechial or purpural rash but no lab confirmation

Identify and count cases (Case Finding)

- May need to go out and look for cases, call hospitals/doctor's offices, phone calls, go door-to-door, media.
- Ask known cases if they know of anyone else who is sick
- Collect case patient information on a standardized case report form (identifying information, demographics, clinical information, risk factors/exposures, reporter information)
- Make a line listing of known cases

5. Perform descriptive epidemiology

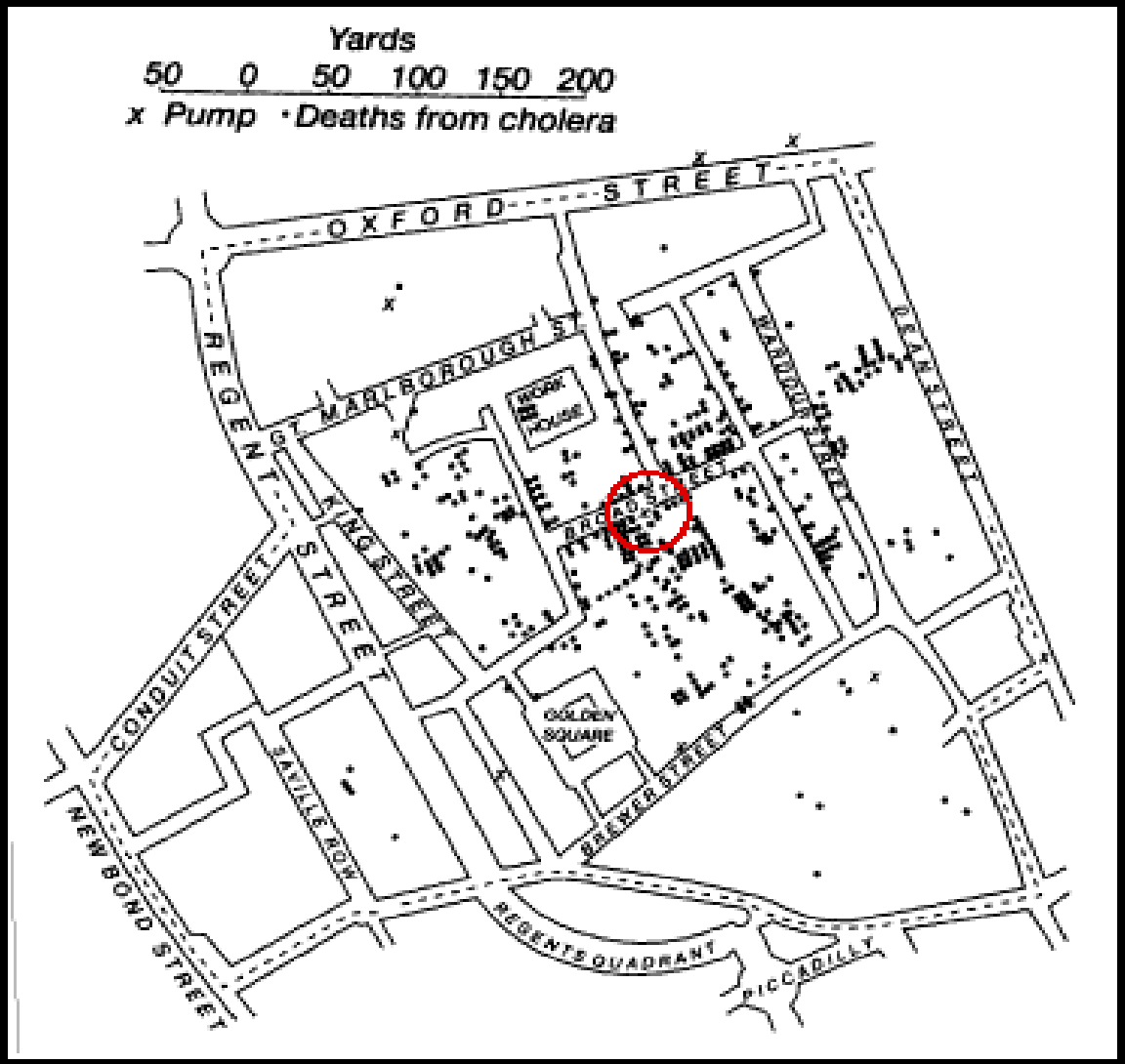
- Person
- Place
- Time

Descriptive Epidemiology: PERSON

- Host characteristics: age, sex, race
- Exposures: home, work, leisure, drugs/medications
- Disease-specific risk factors: activities, sexual exposure, IV drug use

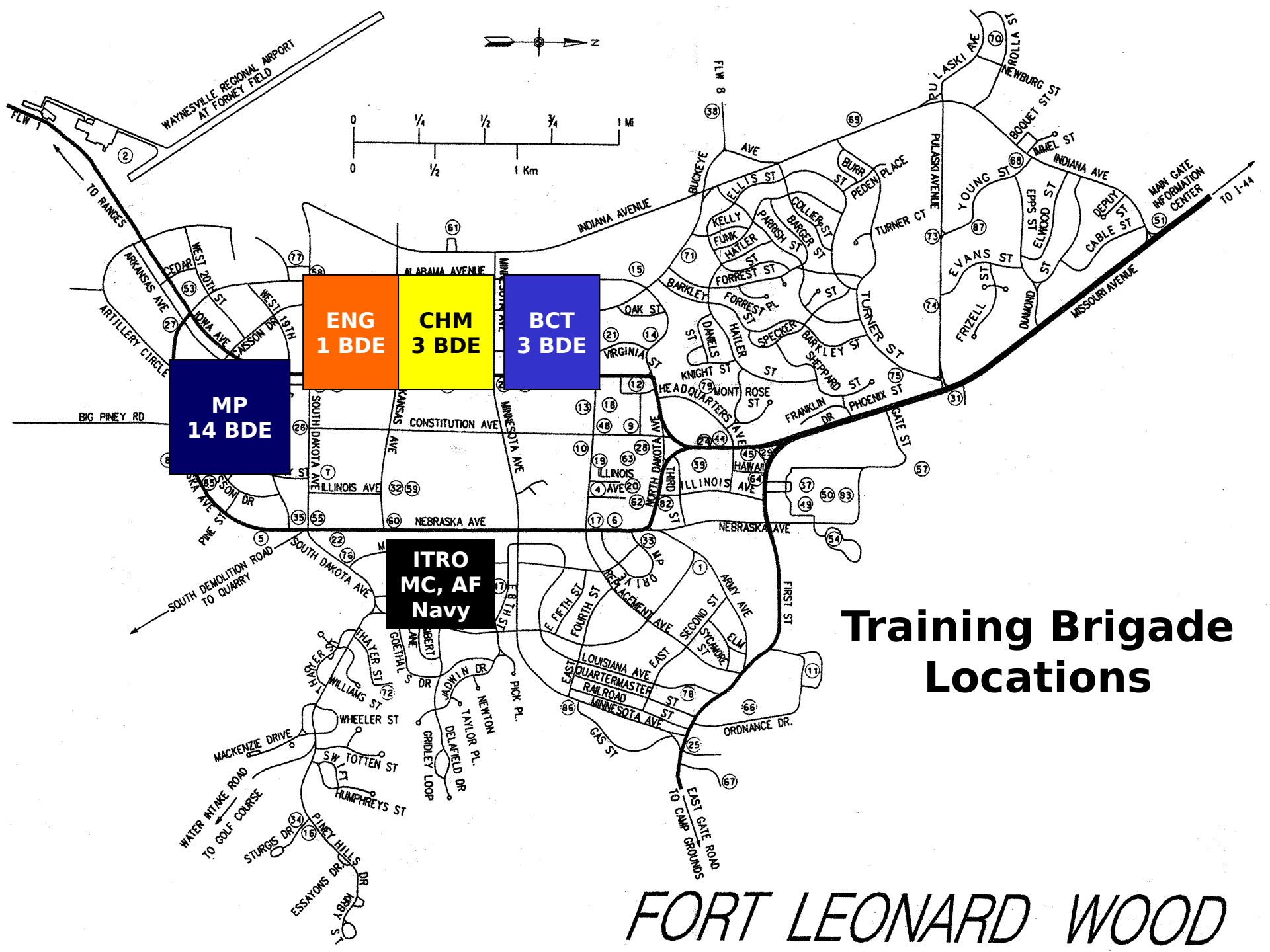
Descriptive Epidemiology: PLACE

- Determine where cases have traveled, where they live/work
- Make a spot map:
  - define geographic spread of the outbreak
  - Identify clusters or patterns



Spot Map

Dr. John Snow
Cholera Map
London 1854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Navy
Training Brigade
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WAYNESVILLE REGIONAL AIRPORT AT FORNEY FIELD
TO RANGES
TO I-44
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ALABAMA AVENUE
CONSTITUTION AVE
NEBRASKA AVE
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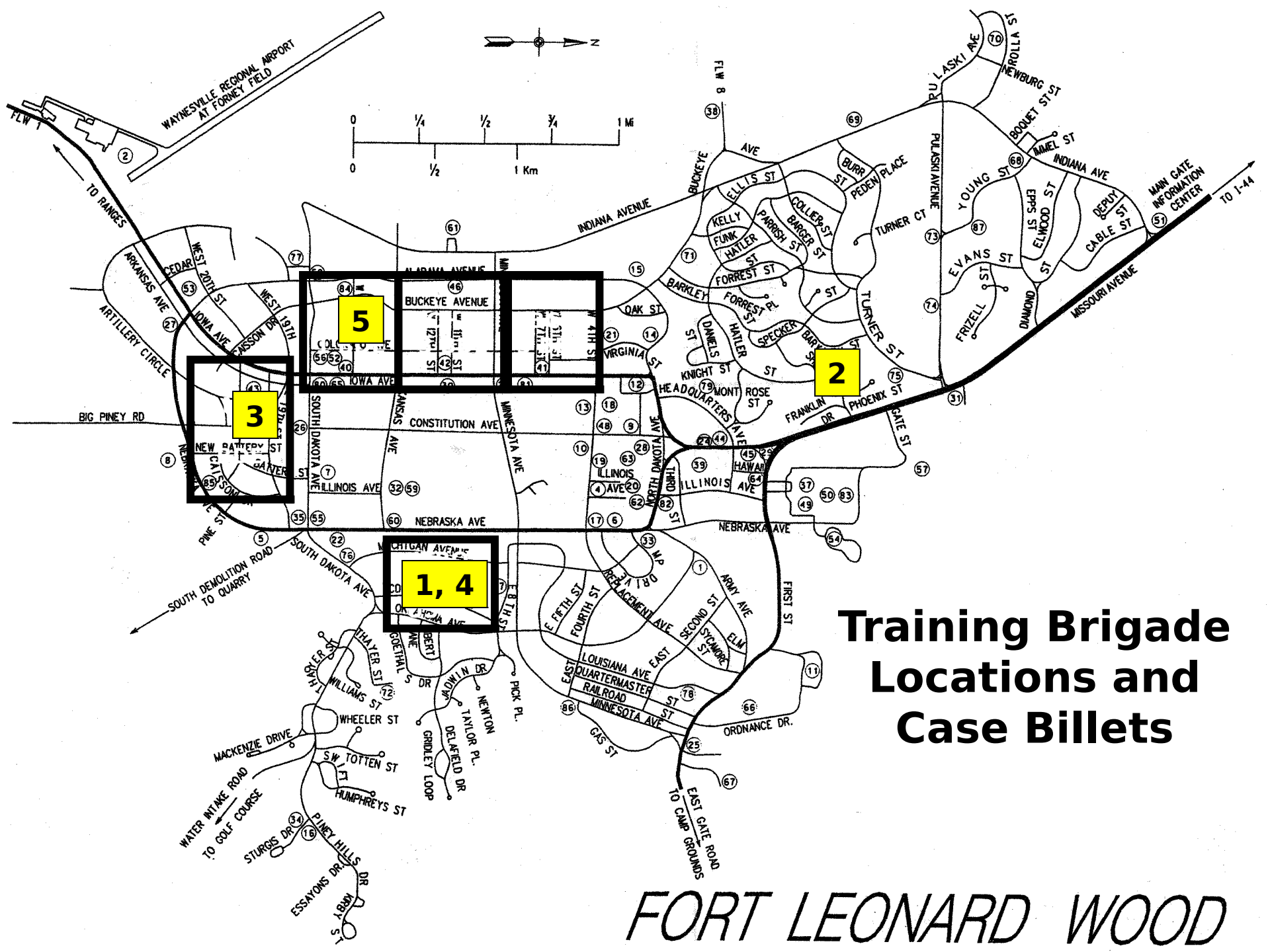
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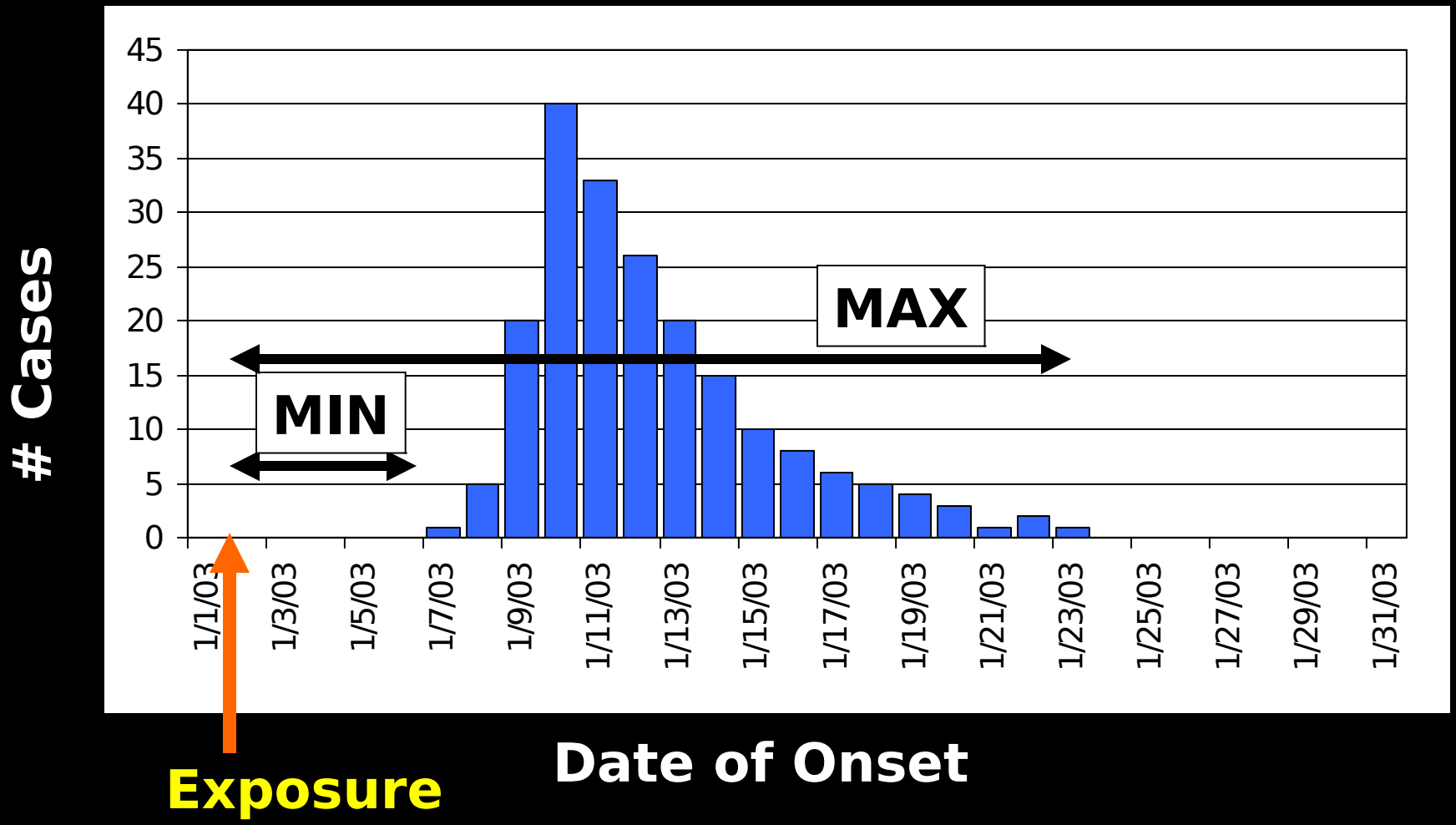
Descriptive Epidemiology: TIME

- Use date of onset (better) or date of diagnosis to draw an Epidemic Curve
- Uses:
  - Magnitude of the outbreak
  - Mode of spread
  - Duration of the epidemic
  - Incubation period

Point Source

- Exposure to a single (point) source during a limited period of time
- Example – contaminated potato salad
- Graph shows a tight clustering of cases
- Rapid rise to a peak
- Trailing downslope
- Can use incubation period range to determine probable time of exposure

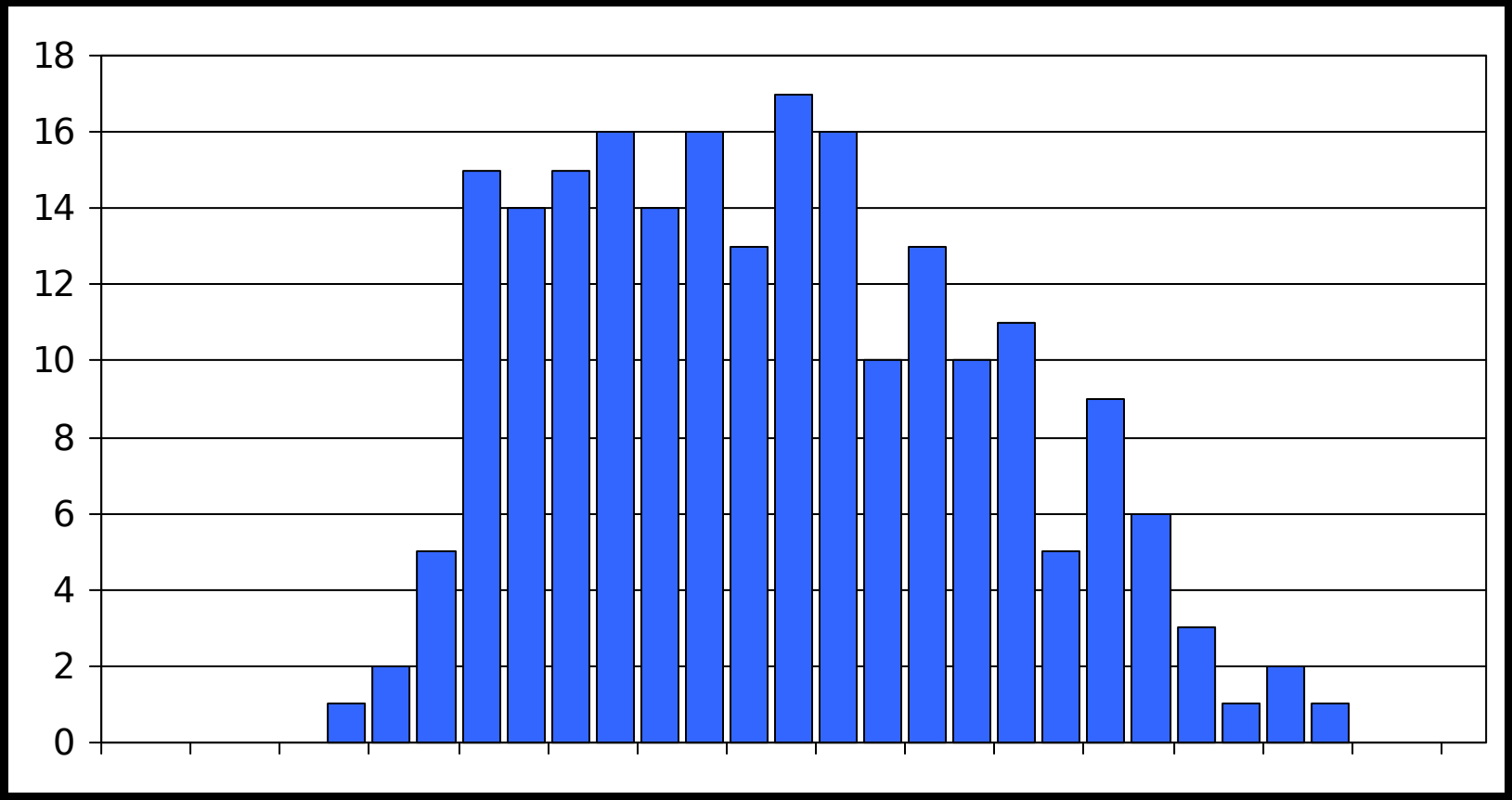
Point Source



Continuing Common Source

- Common source of exposure that continues over time
- Example: bacteria in water system
- Rapid rise to a plateau
- Rapid downslope if source is removed, more gradual if it exhausts itself

Continuing Common Source

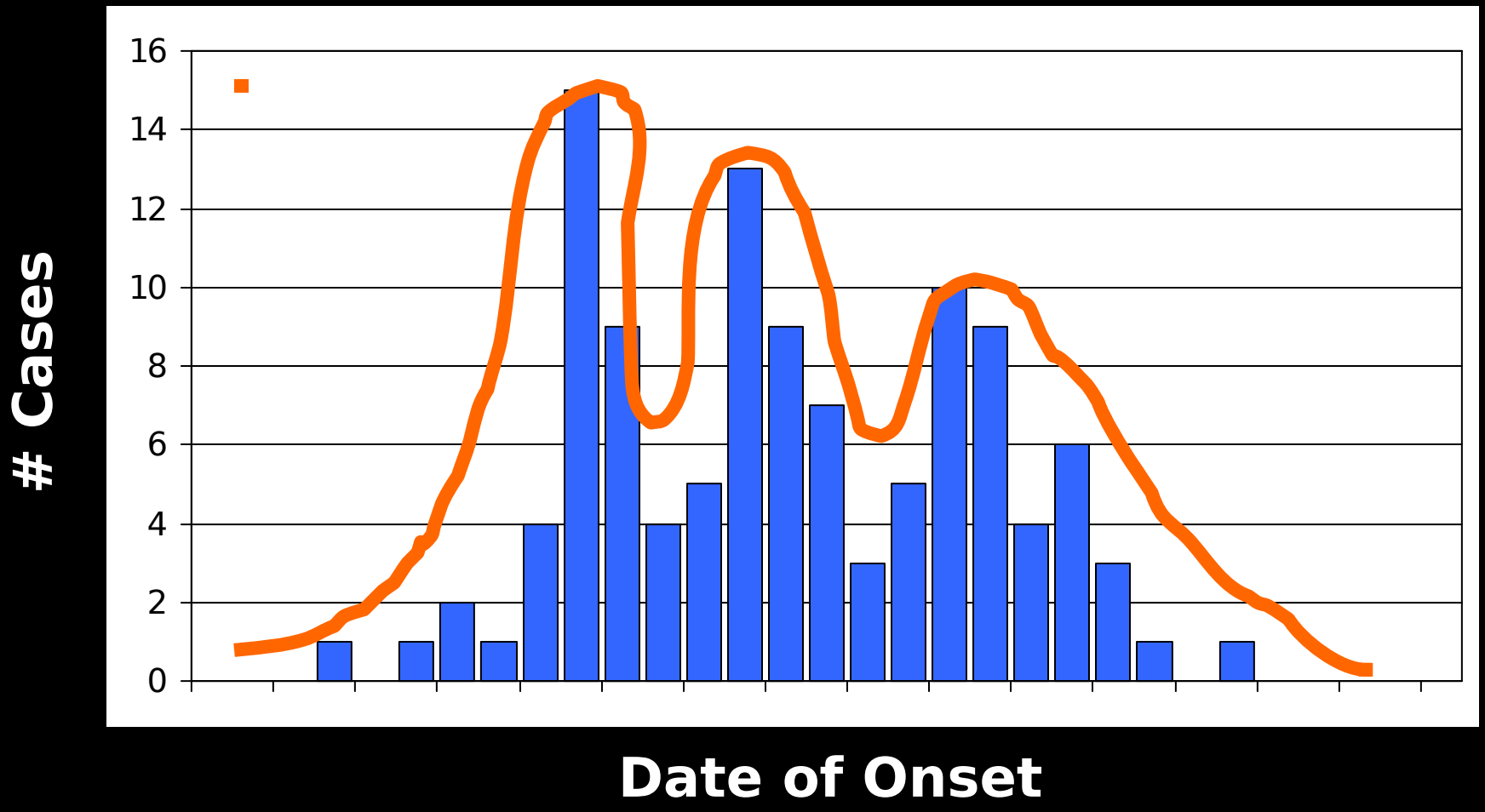


Exposure

Propagated

- Person-to-person spread
- Curve Characteristics:
  - Starts small and gradually rises
  - Encompasses several generation periods for the agent
  - Periodicity equivalent to the generation period
  - Exhaustion of susceptibles may lead to a rapid downslope

Propagated



6. Develop a hypothesis

- Hypothesis should include:
  - Source of the agent
  - Exposures that caused the disease
  - Mode of transmission
- Use patient interviews and what is known about the behavior of the pathogen
- Hypothesis should be testable

7. Evaluate hypothesis

- Two methods:
  - Comparative Method: Compare the hypothesis with the established facts
  - Analytic Epidemiology: Quantify the relationships and rule out the role of chance

Comparative Method

- The “jumps off the page” method
- Overwhelming evidence about what is going on:
  - All cases had the same symptoms and well-documented exposure
  - Lab confirmation obtained
  - Source is identified

Analytic Methods

- When you're not absolutely certain what's going on
- Studies look at association between exposure and disease
- Study Types:
  - Cohort Study (Relative Risk)
  - Case-control Study (Odds Ratio)
- Statistical significance testing (X^2, p-values)

8. Refine hypothesis and execute additional studies

- Need to refine (or replace) hypothesis if your initial investigation is unrevealing
- Re-look at the data from other angles
- Consider new modes of transmission
- Re-interview cases
- Walk around the area, ask questions
- Perform laboratory and environmental investigations

9. Implement control and prevention measures

Eliminate the source: contaminated water or food, kill the rats, etc.

Interrupt transmission: vector control, personal protective measures, hand washing, relocation

Reduce host susceptibility: immunizations, chemoprophylaxis, nutrition

Notes on control programs

- Interventions can be disruptive, expensive, and might not be effective
- Learn from the experience of similar outbreaks
- Involve all of the key players in a community
- Use effective risk communication early and often

10. Communicate findings

- Sitreps, outbriefs, AARs, reports, publications, presentations
- Be concise and objective
- Don’t blindside the people you are there to help
- Include methods and descriptive epidemiology
- Write the final report as a reference and historical document

Some realities:

- You will never have enough time, resources, or information
- Someone will feel like they are being blamed for the outbreak (patients, unit leaders, installation officials, medical officials)
- Everyone will have an agenda
- Be very careful about your findings and recommendations - they can have huge negative consequences
- Use local medical and line resources

Summary

- Outbreaks happen and they can be very disruptive to military operations
- Investigations need to quickly and accurately identify the causes of outbreaks so effective interventions cn be implemented
- There are a number of potential pitfalls so be diligent and conscientious

References

Field Epidemiology, 2nd Ed), Michael B. Gregg, Oxford Univ. Press, 2002

Principles and Practice of Public Health Surveillance, Oxford Univ. Press

Principles of Epidemiology, 2nd Ed, U.S. Dept of Health and Human Services, CDC

Time Check

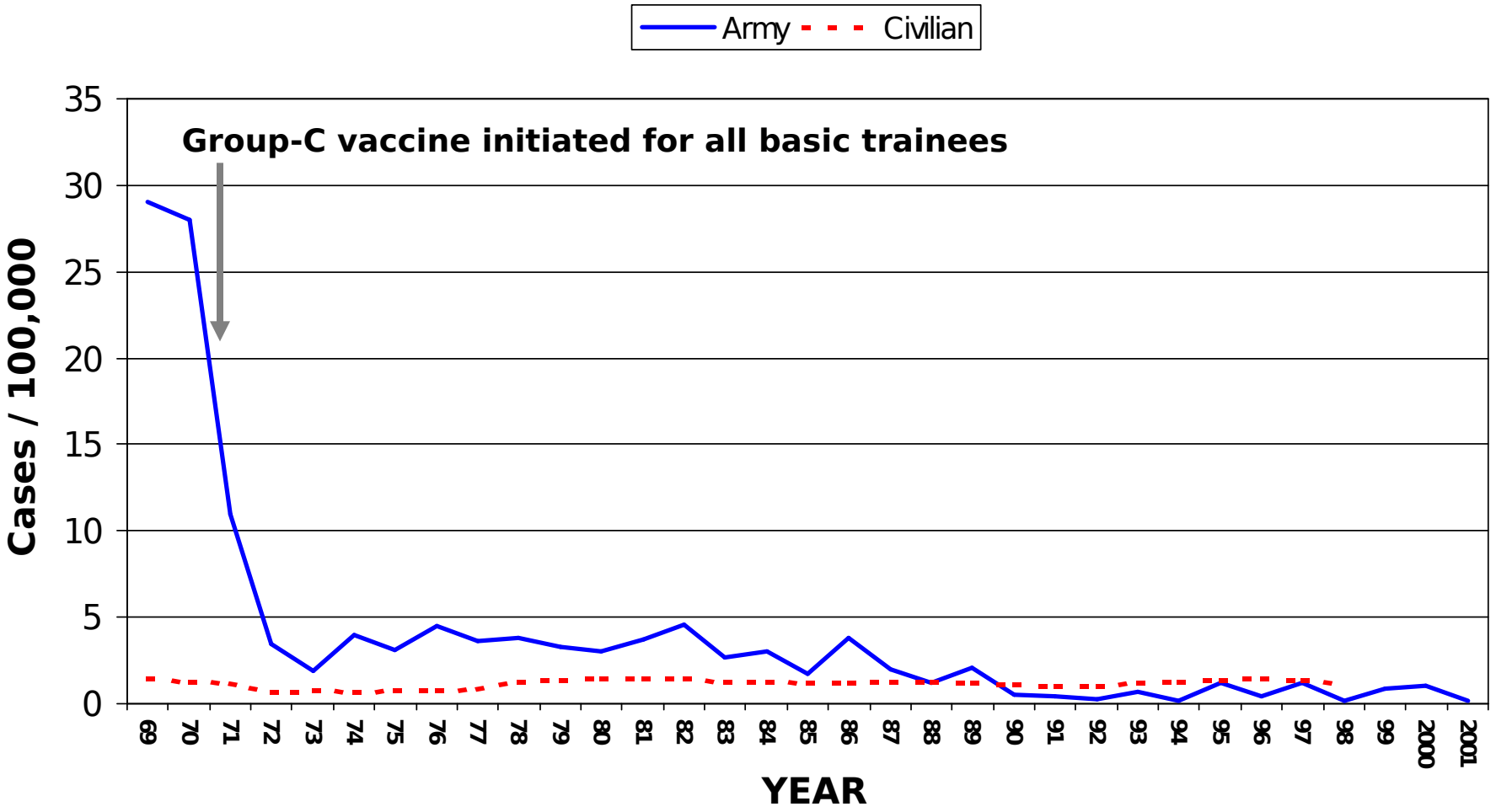
Serogroup C Menigococcal Disease (SCMD) Cluster

Spring 2002

Neisseria meningitidis

- Bacterial infection of the blood / central nervous system
- Many healthy carriers, small number of susceptible become ill
- Safe vaccine prevents disease in 85%. Does not work well in children age 0-2 years. Does not clear carriage
- Risk Groups:
  - Young people at greatest risk and severe disease
  - College students in dormitories
  - Military trainees
- Military trainees have received vaccine against Group-C since 1971

Meningococcal Disease in the U.S. Population (1969-1998)
and the U.S. Army per 100,000 population (1969-2001)



Sources:

1. **Army Hospitalization Data: Army Medical Surveillance Activity, USACHPPM**
2. **Civilian Data: Centers for Disease Control, MMWR, Summary of Notifiable Diseases, 1998**

(Based on disease reporting; may underestimate the incidence of disease in the U.S.

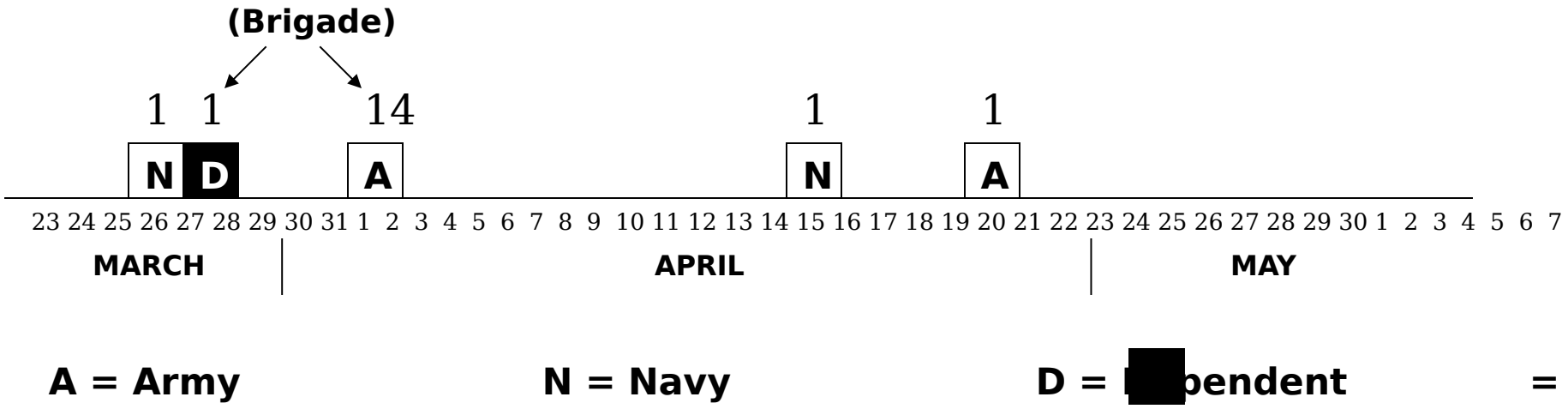
Cluster of Cases

- Five lab confirmed cases at Fort Leonard Wood between 27 March and 27 April 02
- All cases have been the same serogroup and subtype (CDC)
- Four cases in AIT students, one case in a dependent son
- One death (20% case fatality rate)

Summary of Confirmed Cases

Case	Age	Gender	SVC/Unit	Onset	Outcome
1	20	M	NAVY	27 MAR	RTD
2	12	M	DEP ARMY	29 MAR	DIED
3	30	F	ARMY 14 BDE	4 APR	RTD
4	18	M	NAVY	20 APR	RTD
5	20	M	ARMY 1 BDE	27 APR	RTD

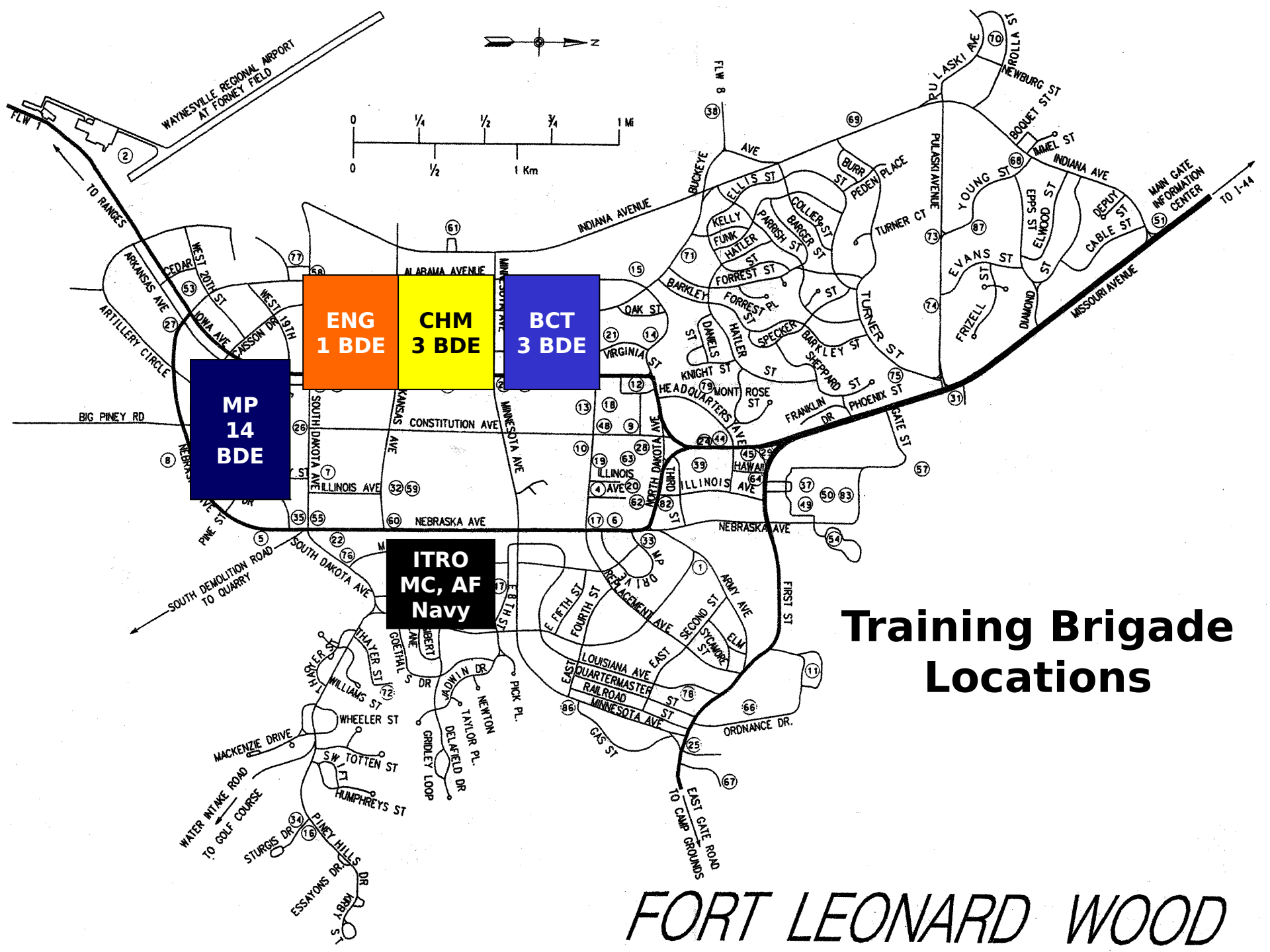
FLW SCMD Cluster: Confirmed Cases
(March-April 2002)



A = Army **N = Navy** **D = [redacted]pendent** **=**

Additional Case Facts

- Four cases had associations with 1st ENG BDE; one with 14th MP BDE
- Three of the four AIT cases had received vaccine with enough time to develop antibodies before disease onset
- The fourth AIT student received vaccine two days before developing disease
- Only the Navy cases had direct contact with each other
- The second Navy case had received antibiotics in March because he was a contact of Case-1
- All four AD cases have returned to duty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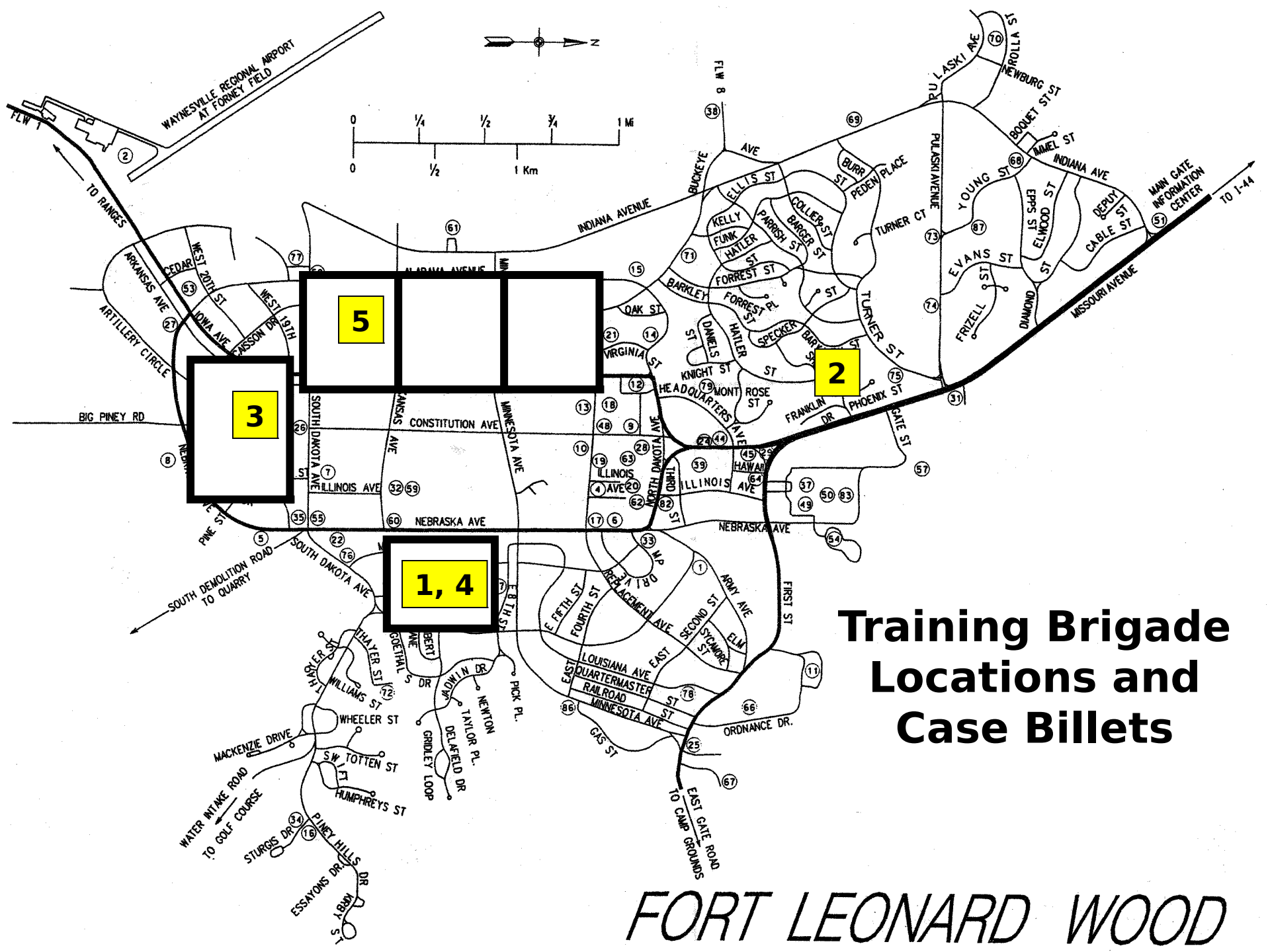
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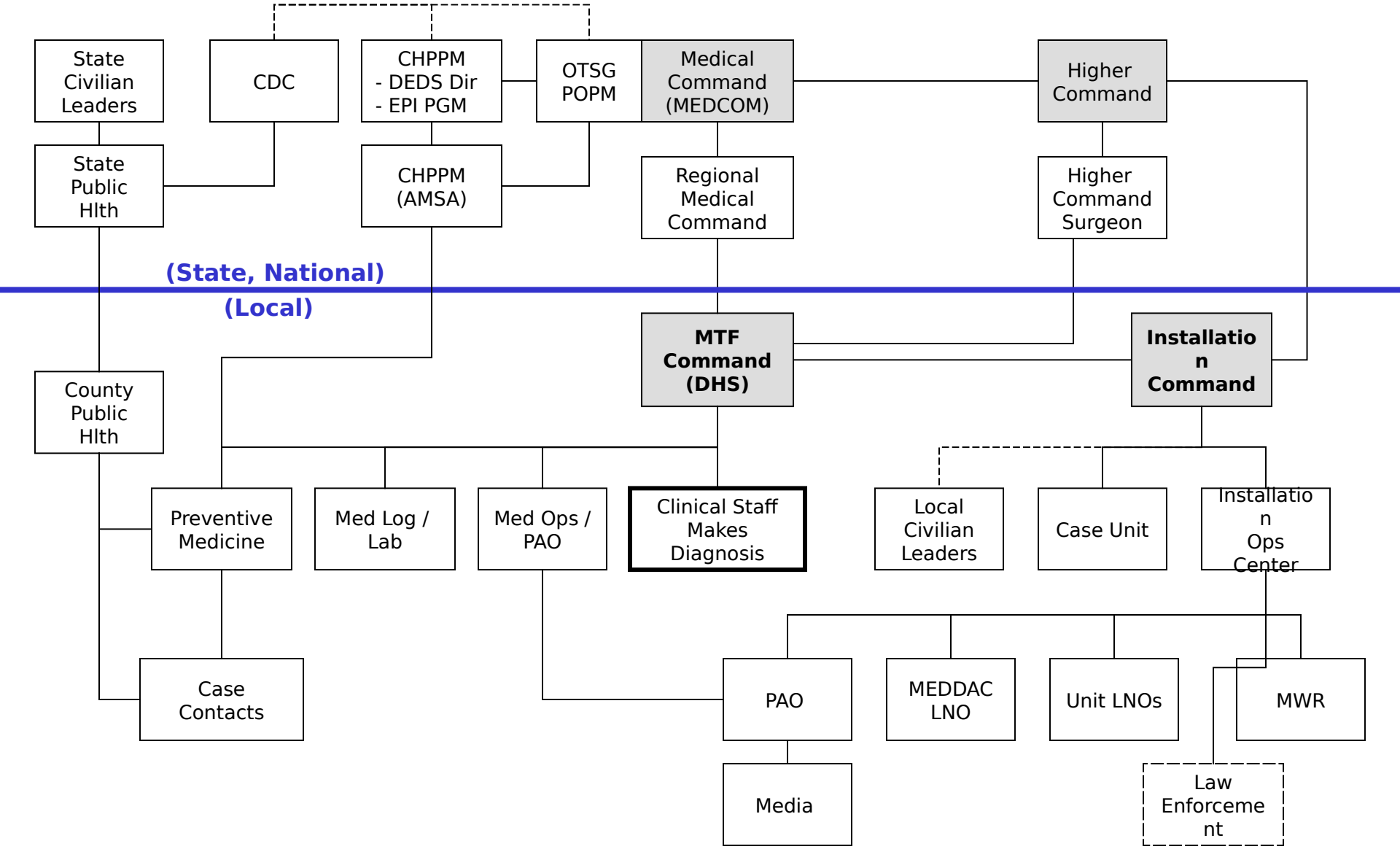
Response Activities

Organizations Involved

- Fort Leonard Wood Command and Community
- General Leonard Wood Army Community Hospital (GLWACH)
- U.S. Army Medical Command / Office of the Surgeon General
- U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM)
- Walter Reed Army Institute of Research (WRAIR)
- Centers for Disease Control and Prevention (CDC)
- Missouri Department of Health and Senior Services
- Pulaski County Health Department
- Local Civilian Officials (Government, Schools)

Information Flow for an Infectious Disease Outbreak at a CONUS Installation

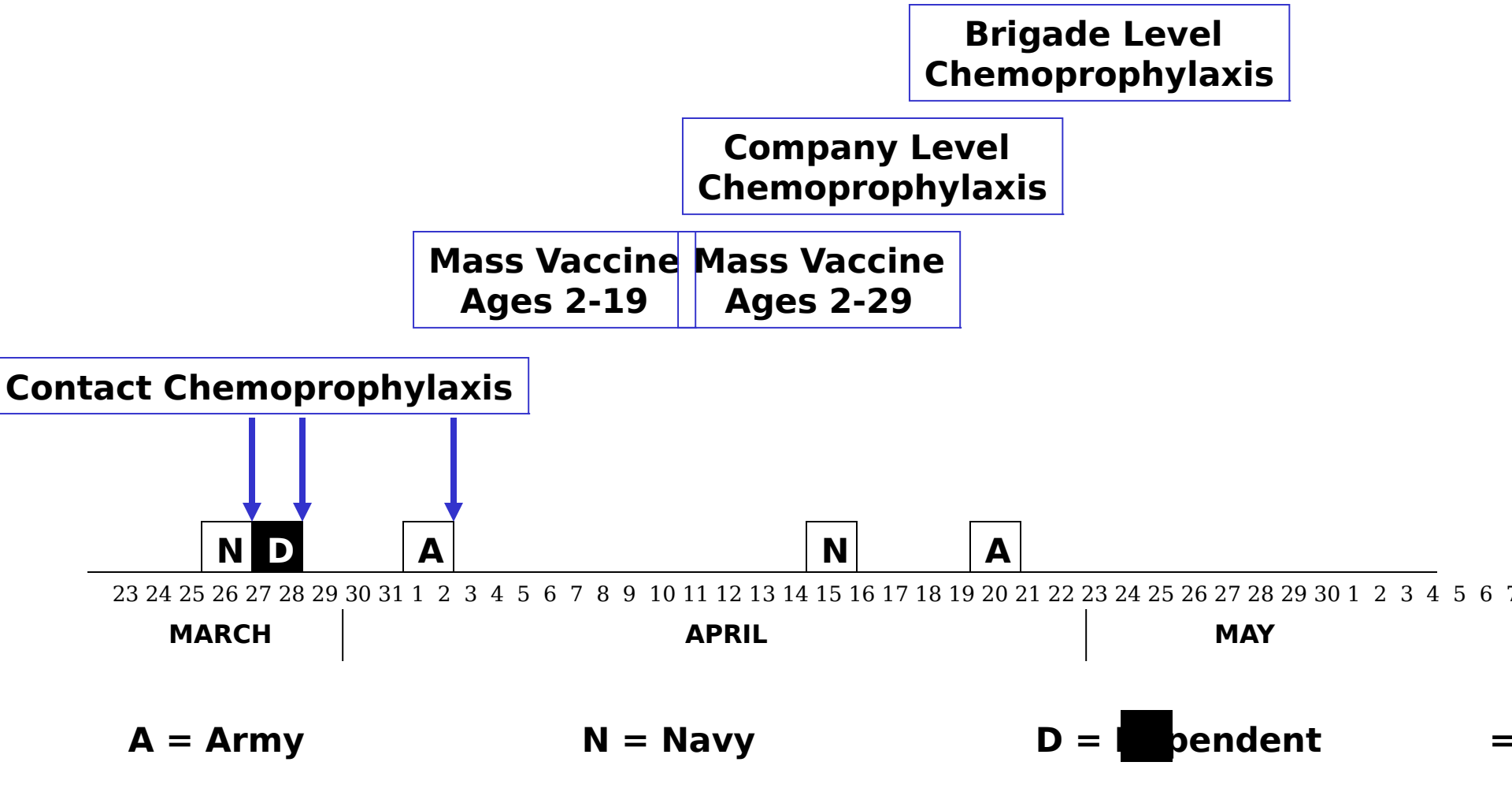


Summary of Phased Interventions

- Routine vaccination of Basic Trainees
- Chemoprophylaxis of close contacts
- Mass vaccination campaign
- Company level chemoprophylaxis
- Brigade level chemoprophylaxis

FLW SCMD Cluster

Summary of Interventions


Brigade Level Chemoprophylaxis
Company Level Chemoprophylaxis
Mass Vaccine Ages 2-19
Mass Vaccine Ages 2-29
Contact Chemoprophylaxis
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MAY

A = Army N = Navy D = [redacted]pendent =

“Complications”

- Schools
  - High School kids off post
  - Civilian kids on post
- Missouri Special Olympics
- Junior ROTC
- Sports Leagues
- Newly assigned personnel
- Civilian workers

Health Information Operations

- Web Site
- Flyers distributed by the MPs
- Phone Bank
- Chain Teaching
- Media (newspapers, radio, TV)
- Meetings and phone calls with civilian officials
- Updates and briefings for senior leaders
- Training for clinicians

Summary Points

- Meningococcal disease outbreaks are frightening – good risk communication is critical
- Coordination is difficult but vital
- Vaccination does not clear carriage but helps protect susceptibles
- Mass prophylaxis usually doesn’t work in community outbreaks because of re-colonization
- Clinicians and public health personnel need to be ready to respond to outbreaks at any time
- Don’t be afraid to ask for help

Thank You

Routine Vaccination of Basic Trainees

- Basic Trainees from all services receive the quadrivalent MGC vaccine for serogroups A,C,Y,W135
- A total of 1169 Army trainees in two cohorts at FLW missed the MGC vaccine:
  - 878 from 10-19 and 31 Jan 02 (20 units)
  - 291 from 14-15 March (8 units)
  - 1159 of the 1169 have now been vaccinated
- No cases have occurred in Basic Trainees

Contact Tracing and Chemoprophylaxis

- Close contacts of cases are at significantly higher risk of disease compared to non-contacts
- Close contacts are defined as household members, daycare contacts, exposed to oral secretions, or over four hours contact with the individual
- Preventive Medicine personnel interviewed the four cases and family members of the fatal case to identify close contacts
- Approximately 290 close contacts received prophylactic antibiotics (usually rifampin) for the first three cases (entire company-level units received antibiotics for cases 4 and 5)

Mass Vaccination Campaign

- Mass vaccination campaigns have been effectively used to interrupt community outbreaks
- The CDC has published guidelines on the use of vaccine in these situations
- After Case-3, the FLW MGC cluster met the CDC definition for a community outbreak: >10 cases per 100,000 population (FLW rate = 14 per 100,000)
- For maximum effectiveness, the FLW mass vaccination campaign first targeted the highest risk group, all people ages 2-19
- After Case-4, the vaccine campaign was extended to include ages 20-29
- 6752 individuals were vaccinated

Company-Level Chemoprophylaxis

- After Case-3 it was determined that any new case in an AD unit would be managed with immediate chemoprophylaxis of the individual's company
- After Case-4, 186 personnel in the Navy Detachment were given antibiotics
- After Case-5, 214 personnel in A-35th ENG BN were given antibiotics

Brigade-Level Chemoprophylaxis

- 1st and 14th Training Brigades were assessed to be at the highest risk for future cases
- Mass chemoprophylaxis campaigns have successfully stopped transmission in military trainees and other closed populations
- After consultation with the Office of the Army Surgeon General, CHPPM, CDC, and the State Health Department, 6335 individuals associated with these two brigades received antibiotics over two days